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Original Research Article

Comparative Evaluation of Alvarado Score and Pediatric Appendicitis Score for the Diagnosis of Acute Appendicitis in Children Undergoing Appendicectomy in AGMC & GBP Hospital

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Abstract:

Introduction: The abdomen is a crucial diagnostic tool for many stomach-related illnesses, and acute appendicitis, a common cause of acute abdomen in surgical practice, has been a subject of ongoing study since its initial report in 1886. The vermiform appendix, a tubular structure from the postero medial portion of the caecum, is located inferior to the ileco caecal junction and is suspended by a fold of peritoneum. It contains the appendicular artery, a branch of the ileocolic artery. Acute appendicitis initially presents with vague symptoms like nausea, anorexia, and indigestion, which may cause vomiting and body temperature rise. Pain migration occurs when pain is overrun by local peritoneal nociception, and histopathologic characteristics include mucosal ulceration, neutrophilic leukocyte invasion, and in some cases, perforation and serositis. Men have an 8.6% lifetime risk of developing acute appendicitis, compared to 6.7% for females. The appendicitis organ has five layers: mucosa, lamina propria, sub mucosa, muscularis, and adventitia. It plays a role in immunity, with lymphoid aggregations in the sub mucosal layer causing an inflammatory response in acute appendicitis. Appendicitis is caused by obstruction of the appendicular lumen, which can be caused by foreign body, crohn's disease, parasite infection, gastroenteritis, upper respiratory tract infection, fecolith, and lymphoid hyperplasia. Appendicitis diagnosis is a complex process involving various investigations, including laboratory and radiological tests, to find the most sensitive test for detecting acute appendicitis. Advancements in modern radiographic imaging and diagnostic laboratory tests have improved diagnostic accuracy and reduced misdiagnosis.

Methodology: This research aims to compare PAS and Alvarado scoring systems for diagnosing acute appendicitis in children. The study involved 70 patients aged 4-14, divided into two groups using either system. Intraoperative findings included inflammation-characterized appendixes and normal ones, with histopathological analysis conducted on all appendicectomy specimens.

Discussion: Clinical scoring systems have been developed to identify the most sensitive, specific, and accurate clinical scores for diagnosing acute appendicitis. The Alvarado score, developed by Samuel, is a well-known and researched method for pediatric appendicitis. A study involving 305 patients found that a score of less than five indicates no appendicitis, while a score of five or six requires observation. The Alvarado method has a sensitivity of 72%, specificity of 81%, and a sensitivity of 92.8%. A PAS score of 6 or higher was highly associated with appendicitis, while a score of 5 or less did not. A study comparing the Alvarado score and PAS for diagnosing acute appendicitis found no significant differences between the two. The study also found no significant differences in PAS scores for diagnosing AA among the 35 participants.

Conclusion: Diagnosing acute appendicitis in pediatric patients remains a challenge, with PAS having better predictive values, sensitivity, and specificity than Alvarado. Further research is needed to determine the best scoring system for pediatric patients.

Keywords: Alvarado score, Appendicectomy, Acute Appendicitis, Pediatric Appendicitis.

Introduction

The abdomen, often compared to a Pandora's box, is a crucial diagnostic tool for many stomach-related illnesses. Despite advancements in medical imaging, the value of a thorough abdominal examination remains unwavering. Acute appendicitis, a common cause of acute abdomen in surgical practice, has been a subject of ongoing study since its initial report in 1886.[1]

Historical Reflection

Ancient Egyptians likely knew about the vermiform appendix, found in graves. Early history did not mention it, and Aristotle and Galenus did not. The first written descriptions of the appendix appeared in the Renaissance, with Leonardo Da Vinci and Andreas Vesalius noticing its presence. Jean Fernel made the first pathologic description in 1544.[2]

Claudius Amyand performed the first appendectomy in 1735 at St George's Hospital in London, scrotally, due to appendicitis in an 11-year-old boy's scrotal hernia. During the 18th and 19th centuries, surgery was exclusive and limited, with treatment for acute appendicitis and its complications limited to incising lower right abdominal abscesses. [3]

The modern era of surgical treatment for acute appendicitis began with the first appendectomy in Edinburgh in 1880, coined by Reingald Fitz in 1886, and first performed in Sweden by Karl Gustav Lennander in 1894.[2]

Anatomy of Appendix

The vermiform appendix is a tubular structure from the postero medial portion of the caecum, located inferior to the ileco caecal junction. Its base is a constant position formed by the confluence of the taenia coli, and its location can influence the diagnosis of appendicitis.

The appendix is suspended by a fold of peritoneum, which is part of the mesentry of the terminal ileum, and attached to the caecum and proximal part of the appendix. This mesoappendix contains the appendicular artery, a branch of the ileocolic artery. The ileocolic and right colic drain the appendix to the portal system.[2]

Sign & Symptoms of Acute Appendicitis

Acute appendicitis initially presents with vague symptoms like nausea, anorexia, and indigestion. It may cause vomiting and body temperature rise. Pain migration occurs when pain is overrun by local peritoneal nociception. Peritoneal irritation and pain migration are the main predictors of appendicitis. Histopathologic characteristics include mucosal ulceration, neutrophilic leukocyte invasion, and in some cases, perforation and serositis.[2]

Men have an 8.6% lifetime risk of developing acute appendicitis, compared to 6.7 percent for females. Between the ages of 10 and 17, the incidence increases from 1-2 cases per 10,000 children annually to four to 25 cases per 10,000 children annually. [3]

Histopathology of Appendix: The appendicitis organ has five layers: mucosa, lamina propria, sub mucosa, muscularis, and adventitia. It lacks digestive glands and secretory ducts, indicating its vestigial nature. It plays a role in immunity, with lymphoid aggregations in the sub mucosal layer causing an inflammatory response in acute appendicitis. Appendicitis is caused by obstruction of the appendicular lumen.[4,5]

The appendicitis is a vestigial organ with five layers: mucosa, lamina propria, sub mucosa, muscularis, and adventitia. It lacks digestive glands and secretory ducts, indicating its vestigial nature. The sub mucosal layer contains lymphoid aggregations, which contribute to the inflammatory response in acute appendicitis. Appendicitis is caused by obstruction of the appendicular lumen, which can be caused by foreign body, crohn's disease, parasite infection, gastroenteritis, upper respiratory tract infection, fecolith, and lymphoid hyperplasia. Mucosal edema and ulceration occur due to overgrowth of bacteria. Increased luminal pressure leads to venous obstruction and vascular congestion, causing pain and inflammation. The appendix may become infarcted and perforated due to tissue ischemia. Rupture of appendicitis can cause inflammatory thickening of the adjacent bowel loop or abscess and collection at the ruptured site.[5,6,7]

Findings on Acute Appendicitis

Appendicitis diagnosis is a complex process involving various investigations, including laboratory and radiological tests, to find the most sensitive test for detecting acute appendicitis. Initially, only clinical symptoms were used to differentiate it from other stomach discomfort causes.

However, advancements in laboratory testing, radiologic examination, and grading systems have improved diagnostic accuracy and reduced misdiagnosis. Despite advancements in modern radiographic imaging and diagnostic laboratory tests, appendicitis diagnosis remains primarily clinical, requiring a combination of observation, clinical acumen, and surgical science.[7,3]

Appendicitis diagnosis is a complex process involving various investigations, including laboratory and radiological tests, to find the most sensitive test for detecting acute appendicitis. Initially, only the patient's history and clinical examinations were used to distinguish it from other causes of stomach discomfort.

However, advancements in modern radiographic imaging and diagnostic laboratory tests have improved diagnostic accuracy and reduced misdiagnosis. The majority of lesions requires further research, treatment, or impacts the patient's prognosis. Routine histopathological examination of the resected appendix can provide further

clinical information and confirm the diagnosis of acute appendicitis, especially where it is not evident intra-operatively.

Histopathological examination may also reveal additional pathologies that may affect the patient's clinical management. Therefore, the continued routine histopathological examination of resected appendix is justified due to the potential impact on patient management.[7,5]

Technologies to assist in the diagnosis of appendicitis have been developed in an attempt to shorten the time required for diagnosis. These rating schemes are predicated on whether symptoms are present or absent.

The most widely used system is the Alvarado score. For categorizing cases of sudden appendicitis. Although it was designed with adults in mind, it has been validated in numerous studies with pediatric patients as well.[1]

Alfred Alvarado developed the Alvarado score in 1986, a 10-point clinical scoring system based on eight factors including focal RLQ tenderness, leukocytosis, migratory pain, fever, anorexia, nausea/vomiting, and rebound tenderness.[8]

Table 1: Alvarado Scoring System

Symptoms	**Variable**	**Score**	
	Migration of pain	**Yes**	**No**
		1	0
	Anorexia	1	0
	Nausea/vomiting	1	0
Signs	Right lower quadrant tenderness	2	0
	Rebound pain	1	0
	Elevation of temperature ≥37.3ºC	1	0
Laboratory	Leukocytosis ≥10 × 10^9/L	2	0
	Polymorphonuclear neutrophilia ≥75%	1	0

Table 2: Interpretation of Scoring System

1-4	→	Appendicitis unlikely
5-6	→	Appendicitis possible
7-8	→	Appendicitis probable
≥ 9	→	Appendicitis definitive

In 2002, Samuel introduced a new scoring system specifically designed for the pediatric population: the Pediatric Appendicitis Score (PAS). The author determined a cut point at which surgery is advised over observation for each score. In a five-year study involving 1170 English children (ages 4 to 15), the sensitivity, specificity, positive, and negative predictive values of PAS were 100%, 92%, 96%, and 99%, respectively [2]. In children, a PAS score of six or higher is associated with appendicitis.[8]

Table 3: Pediatric Appendicitis Scoring System

Symptoms	**Variable**	**Score**	
	Migration of pain	**YES**	**NO**
		1	0
	Anorexia	1	0
	Nausea/vomiting	1	0
Signs	Right lower quadrant tenderness	2	0
	Rebound pain	2	0
	Elevation of temperature ≥37.3ºC	1	0
Laboratory	Leukocytosis ≥10 × 10^9/L	1	0
	Polymorphonuclear neutrophilia ≥75%	1	0

The study aims to assess and compare the Alvarado scoring and PAS in children with AA for diagnosing appendicitis and distinguishing severe cases from appendicitis in the pediatric population.

The research is focused on evaluating the scoring systems among the pediatric population of Tripura undergoing appendecectomy at AGMC & GBP Hospital, using histopathology as the gold standard. The diagnostic accuracy of these scoring systems is still unknown.

Aim & Objectives

Goal: The study's objective is to assess and contrast the Pediatric Appendicitis Scoring Systems and the Alvarado Scoring System for the diagnosis of acute appendicitis in the pediatric population.

The goals

- To evaluate the Alvarado scoring and PAS systems' sensitivity, specificity, positive predictive value (PPV), and negative predictive

value (NPV) for the diagnosis of acute appendicitis in children having appendicectomies.
- To ascertain whether, using the AS and PAS scoring systems, there are any appreciable differences between those with acute appendicitis and those who do not.
- To ascertain whether the Alvarado scoring system and the PAS differ significantly from one another using histopathological findings as the gold standard.

Methodology

The goal of the current study is to examine and contrast, using gold standard histopathology, the Alvarado scores and the Pediatric appendicitis scoring system among the pediatric population undergoing appendicectomy who were admitted to Agartala Government Medical College & GBP Hospital between January 2020 and June 2021.

Study Design: Cross sectional study design.

Study period: One and half years.

Study Population: All children, 4 to 14 year old presenting to the Surgery department of AGMC & GBP Hospital with Acute Appendicitis.

Inclusion Criteria

- Children must fall in 4 to 14 year age group and presenting to the Emergency department of AGMC & GBP Hospital with abdominal pain.
- Duration of the abdominal pain complained by the patient authority ≤ 3 days.
- Children suspected of acute appendicitis and undergoing appendicectomy.

Exclusion Criteria

- History of known chronic abdominal pathology.
- Patients or the patient authority not willing to participate in the study.

Size of Sample:

There are 70 participants in total for the study, of which 60 have acute appendicitis and 10 have non-acute appendicitis.

Sampling Method:

Census sampling method is used to collect the data during the study period.

Study Methods:

The goal of this research is to assess and contrast the PAS and Alvarado scoring systems for the diagnosis of acute appendicitis in children. In relation to histopathology as the gold standard, any significant differences in the two scoring systems' sensitivity, specificity, PPV, and NPV will be ascertained. Lastly, it will be determined whether PAS has a higher predictive value for diagnosing acute appendicitis in the pediatric population.

The study involved 70 pediatric patients aged 4-14 who underwent appendicectomy. Two groups were created, with 35 patients in each group using Alvarado score or PAS. Intraoperative findings were recorded, with abnormal appendixes characterized by inflammation, swollen appendix, burst appendix, or appendicular abscess, and normal appendixes without inflammation. Histopathological analysis was conducted on all appendicectomy specimens.

Data Collection and Evaluation

This study includes all pediatric patients who underwent emergency appendicitis-related appendectomy at AGMC & GBP Hospital's Surgery Department between January 2020 and June 2021. All parents gave their consent after being fully informed about the study by the patient parties.

The patient's age, sex, gender, laboratory results (leukocyte, C-reactive protein, and neutrophils), length of illness, and the items from the Alvarado and PAS systems were all recorded on a data sheet.

The intraoperative results were documented, and every specimen was sent to the lab for a pathologist's additional review. Lately, patients were split into two groups: Acute Appendicitis (AA) and Non-Acute Appendicitis (Non-AA), based on the histopathological findings.

Assessment through statistical analysis carried out on a PC with SPSS for Windows. Information displayed as text, tables, charts, etc. The significance of the difference between two proportions was tested using the T-test, and a p-value of less than 0.05 was deemed statistically significant.

Result

Table 4: Stratification of total enrolled patients with regard to gender

Sex	Frequency	Percent
Female	25	35.7
Male	45	64.3
Total	70	100

Table:4 shows the sex distribution of no of study group among the 70 patients taken for surgery. The table shows the predominance of male patient in the study sample with about 64.3% and females are 35.7%.

Table 5: Histopathological findings in diagnosis of Acute Appendicitis

HPE (N=70)	Parameters	Frequency	Percent
	AA	58	82.9
	Non-AA	12	17.1
	Total (N)	70	100

Table 5 the above table shows the number of case reported positive for appendix in the 70 study sample, 58 patients were positive and 12 were negative; groups based on AS & PAS separately.

Table 6: Histopathological findings in diagnosis of Acute Appendicitis

AS (n=35)	Scoring System	Frequency	Percent
	AA	28	80.0
	Non-AA	7	20.0
PAS (n=35)	AA	30	85.7
	Non-AA	5	14.3
	Total (N)	70	100

Table 6 the above table shows the number of case reported positive for appendix in the 70 study sample, 58 patients were positive and 12 were negative; groups based on AS & PAS separate

Table 7: Descriptive Statistics of the variables

	HPE	N	Mean	Std. Deviation	Std. Error Mean
AS	AA	28	7.64	0.870	0.164
	Non-AA	7	8.29	1.113	0.421
PAS	AA	30	7.87	0.629	0.115
	Non-AA	5	7.60	0.548	0.245

Table 8: Statistics of all study variables (for operated cases, n=70) 1. Final Diagnosis * Alvarado Score

AS							Total
			7	8	9	10	
FD	AA	Count	16	7	4	1	28
		% within FD	57.1%	25.0%	14.3%	3.6%	100.0%
	NON-AA	Count	2	2	2	1	7
		% within FD	28.6%	28.6%	28.6%	14.3%	100.0%
Total		Count	18	9	6	2	35
		% within FD	51.4%	25.7%	17.1%	5.7%	100.0%

Table 9: Each subscript letter denotes a subset of Final Diagnosis categories whose column proportions do not differ significantly from each other at the .05 level. 2. Final Diagnosis * PAS

	PAS					
			7	8	9	Total
FD	AA	Count	8	18	4	30
		% within FD	26.7%	60.0%	13.3%	100.0%
	NON-AA	Count	2	3	0	5
		% within FD	40.0%	60.0%	0.0%	100.0%
Total		Count		10	4	35

Table 10: Final Diagnosis categories whose column proportions do not differ significantly from each other at the .05 level. 3. HPE * Alvarado Score

	AS						
			7	8	9	10	Total
HPE	AA	Count	16	7	4	1	28
		% within AS	88.9%	77.8%	66.7%	50.0%	80.0%
	NON-AA	Count	2	2	2	1	7
		% within AS	11.1%	22.2%	33.3%	50.0%	20.0%
Total		Count		18	6	2	35
		% within AS		100.0%	100.0%	100.0%	100.0%

Table 11: shows the PPV as 80.0% & NPV as 20.0% of Alvarado scoring system in diagnosing Acute Appendicitis. 4. HPE * PAS

PAS						
7				8	9	Total
HPE	AA	Count	8	18	4	30
		% within PAS	80.0%	85.7%	100.0%	85.7%
	NON-AA	Count	2	3	0	5
		% within PAS	20.0%	14.3%	0.0%	14.3%
Total		Count	10	21	4	35
		% within PAS	100.0%	100.0%	100.0%	100.0%

Table.10 shows the PPV (85.7%) with NPV (14.3%) of PAS in predicting acute appendicitis in pediatric population.

Discussion

Numerous studies have been conducted since the idea of clinical scoring systems was first proposed in an effort to identify the clinical score that would be most helpful in diagnosing acute appendicitis while also being the most sensitive, specific, and diagnostically accurate.

Alvarado is one of the most well-known and researched scores for acute appendicitis since it was first introduced in 1986. But Samuel developed the Pediatric Appendicitis Scoring system specifically for the pediatric population, which uses a standardized cutoff point to diagnose acute appendicitis and assess if additional surgery is necessary.

Early diagnosis of acute appendicitis is crucial to reduce morbidity and mortality, with a recent study showing a 22% unwarranted appendectomie rate.

Data from 305 patients who had been diagnosed with suspected appendicitis were used to calculate the Alvarado score. Eight predicted markers had their sensitivity and specificity assessed retroactively in the patient charts. If the score is less than five, Alvarado says that the patients can be released as not having appendicitis. A score of five or six required observation, while a score of seven or higher necessitated surgery as the patient was probably suffering from appendicitis.

Schneider et al. and Mandeville et al. found that the Alvarado method, which uses a 7-point cutoff value for appendicitis, has a PPV of 65%, NPV of 46%, sensitivity of 72%, and specificity of 81%. This method has been widely used in diagnosing acute appendicitis, with a study involving 35 pediatric patients showing 57.1% sensitivity and 28.6% specificity.

Samuel's study found that a PAS score of 6 or higher was highly associated with appendicitis, while a score of 5 or less did not. Schneider et al. found similar results, with a sensitivity of 92.8% and a specificity of 69.3%. However, a PAS score of 7 or higher had a sensitivity of 60%, a specificity of 40%, a PPV of 85.7%, and NPV of 14.3%.

The study compares the Alvarado score and PAS for diagnosing acute appendicitis, incorporating qualitative data and using an independent t-test for a more comprehensive understanding. After all 70 case records were examined, it was found that approximately 35.7% of the patients were female and 64.3% were male. Everybody had had an appendix removed. With 70 case records, the study population's mean age was 9.06 (SD 3.050); the range was 4–14 years. According to histopathological findings, 17.1% of the patients in the study had a negative appendectomy, which was predicted by both the PAS and the Alvarado score overall. In contrast, Alvarado's independent t-test analysis

When using the Alvarado scores to diagnose acute appendicitis at 95% confidence interval, the score within the AA group showed df of 33 and 7.932 respectively, with p-value at 0.107 and t-value at -1.656 (critical value t=2.035, 0.05%), suggesting that there are no statistically significant differences between AA and Non-AA participants.

The study found no significant differences in PAS scores for diagnosing AA among the 35 participants, suggesting that the analytical data could influence 37% of the population, despite no statistically significant differences at 95% confidence level.

Statistical analysis found no significant differences between Alvarado scores and PAS system for diagnosing acute appendicitis in Tripura's pediatric population undergoing appendectomy.

Conclusion

For treating surgeons, diagnosing acute appendicitis still poses a mysterious challenge.

In comparison to Alvarado, PAS has better predictive values, sensitivity, and specificity in our investigation. While Alvarado and PAS both significantly aid in establishing the clinical diagnosis, none of them have sufficient predictive values to evaluate the diagnosis of acute appendicitis in pediatric patients. To minimize negative appendicitis, more research in this area is needed to determine which scoring system is best

for the pediatric population.

Limitations

The study was conducted in a limited period of time. Duration of one and half year is not enough to safely conclude about the outcome of study

The study population was also less enough to safely conclude about the study

It was retrograde study where data collected from the pediatric patients who already undergone appendicectomy operation

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